PHYSICS

Departmental Office: 704 Pupin; 212-854-3348
http://www.columbia.edu/cu/physics

Director of Undergraduate Studies: Dr. Jeremy Dodd, 924 Pupin; 212-854-3969; jeremy.dodd@columbia.edu

The physics major offers a rigorous preparation in the intellectual developments of modern physics, along with extensive exposure to the mathematical and experimental techniques required to conduct basic and applied research in physics.

For the major, the department offers a set of required courses well-suited to prepare students for the most rigorous course of graduate study. These can be supplemented by elective courses in a variety of advanced topics. Although most majors go on to graduate work in physics, the intellectual skills acquired in the study of physics can also provide the basis for work in a variety of other scientific and nonscientific areas.

The physics concentration is for students who are interested in physics but are uncertain about graduate study in physics; for those who want to explore other subjects along with physics; for those who want to find a physics- or technology-related job after graduation; or for those who are considering a professional school such as law or medicine. The department helps concentrators custom design programs to ensure maximum flexibility in meeting students' intellectual needs and career goals. With appropriate selection of courses, the concentrator can explore other subjects yet maintain the option of graduate study in physics.

Research is an extremely important component of the Columbia physics experience. Because the department has a very small student-to-faculty ratio, essentially all physics majors and concentrators engage in experimental, computational, or theoretical research under the close supervision of a faculty member during part, if not all, of their time at Columbia.

Registration for Introductory Courses

The department offers a stand-alone one-semester course for nonscience majors, one introductory sequence in physics intended primarily for preprofessional students, and three introductory sequences in physics for engineering and physical science majors. Students are given credit for courses from only one of the different sequence groups.

Mixing courses across the sequences is strongly discouraged; however, physics majors who begin their studies with PHYS UN1401 INTRO TO MECHANICS # THERMO - PHYS UN1402 INTRO ELEC/MAGNETSM # OPTCS should take PHYS UN2601 PHYSICS III:CLASS/QUANTUM WAVE as the third-semester course.

Introductory Sequences

Nonscience Majors:

PHYS UN1001	PHYSICS FOR POETS

Preprofessional Students:

PHYS UN1201 - PHYS UN1202	GENERAL PHYSICS I and GENERAL PHYSICS II
Accompanying laboratory course:	
PHYS UN1291 - PHYS UN1292	GENERAL PHYSICS I LAB and GENERAL PHYSICS II LABORATORY

Engineering and Physical Science Majors:

Select one of the following sequences with accompanying laboratory course:

Sequence A:	
PHYS UN1401 - PHYS UN1402 - PHYS UN1403	INTRO TO MECHANICS # THERMO and INTRO ELEC/MAGNETSM # OPTCS and INTRO-CLASSCL # QUANTUM WAVES
Sequence B:	
PHYS UN1601 - PHYS UN1602 - PHYS UN2601	PHYSICS I:MECHANICS/RELATIVITY and PHYSICS II: THERMO, ELEC # MAG and PHYSICS III:CLASS/QUANTUM WAVE
Sequence C:	
PHYS UN2801 - PHYS UN2802	ACCELERATED PHYSICS I and ACCELERATED PHYSICS II

Sequence A is a self-contained group of three courses, while Sequences B and C anticipate more course work in the Physics Department. Students considering a physics major are strongly encouraged to begin one of these sequences in their first year.

Laboratory

Many of the introductory courses include a laboratory, as indicated. A $75 per term *laboratory fee* is charged for all *1000*-level and *2000*-level laboratories.

Advanced Placement

Students may earn a maximum of 6 credits in physics. The department grants 6 credits for a score of 4 or 5 on the AP Physics B exam, but the student is not entitled to any exemptions. The amount of credit is reduced to 3 if the student takes a *1000*-level physics course.

The department grants 3 credits for a score of 4 or 5 on the AP Physics C/MECH exam, but the student is not entitled to any exemptions. The amount of credit is reduced to 0 if the student takes PHYS UN1001, PHYS UN1201, PHYS UN1401 or PHYS UN1601.

The department grants 3 credits for a score of 4 or 5 on the AP Physics C/E&M exam, but the student is not entitled to any exemptions. The amount of credit is reduced to 0 if the student takes PHYS UN1001, PHYS UN1202,PHYS UN1402 or PHYS UN1602.

Professors

Igor Aleiner
Boris Altshuler
Elena Aprile
Dmitri Bassov
Andrei Beloborodov
Allan Blaer (*emeritus*)
Gustaaf Brooijmans
Norman Christ
Brian Cole
Frederik Denef
Richard Friedberg (*Barnard emeritus*)
Brian Greene (Mathematics)
Miklos Gyulassy (*emeritus*)
Charles J. Hailey
Timothy Halpin-Healy (Barnard)
Sven Hartmann (*emeritus*)
Tony Heinz (*emeritus*)
Emlyn Hughes

Lam Hui
Laura Kay (Barnard Astronomy)
Tsung Dao Lee (*emeritus*)
Yuri Levin
Szabolcs Marka
Robert Mawhinney (Chair)
Andrew Millis
Alfred H. Mueller
Reshmi Mukherjee (Barnard)
John Parsons
Aron Pinczuk (Applied Physics)
Malvin Ruderman
Frank Sciulli (*emeritus*)
Michael Shaevitz
Michael Tuts
Yasutomo Uemura
Erick Weinberg
William Zajc

Associate Professors

Brian Humensky
Janna Levin (Barnard)
Brian Metzger
Alberto Nicolis
Abhay Pasupathy
Ozgur Sahin (Biology)
Tanya Zelevinsky

Assistant Professors

Cory Dean
Bradley Johnson
Georgia Karagiorgi
Rachel Rosen
Sebastian Will

Senior Lecturer in Discipline

Jeremy Dodd

Adjunct Professor

Morgan May

Lecturer

Burton Budick
Eric Raymer

On Leave

Amber Miller

Guidelines for all Physics Majors, Concentrators, and Interdepartmental Majors

Majors and concentrators should plan their programs of study with the director of undergraduate studies before the beginning of the junior year.

Prospective physics majors are strongly encouraged to begin one of the introductory physics sequences in their first year. Majors should aim to acquire as extensive a background in mathematics as possible.

The department considers laboratory experience to be an essential part of the physics curriculum. Majors and concentrators can gain such experience in the intermediate-level laboratories, the electronics laboratory, and through experimental research in faculty research groups.

Grading

A grade of C- or better must be obtained for a course to count toward the majors or the concentration. The grade of P is not acceptable, but a course that was taken P/D/F may be counted if and only if the P is uncovered by the Registrar's deadline.

Major in Physics

Physics Courses

The major in physics requires a minimum of 41 points in physics courses, including:

Introductory Sequences	
Select one of the following sequences:	
Sequence A: Students with a limited background in high school physics may elect to take:	
PHYS UN1401 - PHYS UN1402 - PHYS UN2601	INTRO TO MECHANICS # THERMO and INTRO ELEC/MAGNETSM # OPTCS and PHYSICS III:CLASS/QUANTUM WAVE
Sequence B:	
PHYS UN1601 - PHYS UN1602 - PHYS UN2601	PHYSICS I:MECHANICS/RELATIVITY and PHYSICS II: THERMO, ELEC # MAG and PHYSICS III:CLASS/QUANTUM WAVE
Sequence C: Students with advanced preparation in both physics and mathematics may be eligible to take:	
PHYS UN2801 - PHYS UN2802	ACCELERATED PHYSICS I and ACCELERATED PHYSICS II
Core Physics Courses	
PHYS UN3003	MECHANICS
PHYS UN3007	ELECTRICITY-MAGNETISM
PHYS UN3008	ELECTROMAGNETIC WAVES # OPTICS
PHYS GU4021	QUANTUM MECHANICS I
PHYS GU4022	QUANTUM MECHANICS II
PHYS GU4023	THERMAL # STATISTICAL PHYSICS
Elective Courses	
Select at least six points of the following courses:	
PHYS UN3002	From Quarks To the Cosmos: Applications of Modern Physics
PHYS GU4003	ADVANCED MECHANICS
PHYS GU4011	PARTICLE ASTROPHYS # COSMOLOGY
PHYS GU4018	SOLID STATE PHYSICS
PHYS GU4019	MATHEMATICL METHODS OF PHYSICS
PHYS GU4040	INTRO TO GENERAL RELATIVITY
PHYS GU4050	Introduction to Particle Physics
With the permission of the Director of Undergraduate Studies, 4000- or 6000-level courses offered in this or other science departments	
Laboratory Work at the Intermediate Level *	
Select one of the following options:	
Option 1:	
PHYS UN3081	INTERMEDIATE LABORATORY WORK (two semesters)

PHYS UN3083	ELECTRONICS LABORATORY
Option 2:	
PHYS UN3081	INTERMEDIATE LABORATORY WORK (three semesters)
Senior Seminar	
PHYS UN3072	SEM IN CURRENT RES. PROBLEMS

* Approved experimental work with a faculty research group may satisfy one semester of the laboratory requirement.

Mathematics Courses

Calculus through MATH UN1202 CALCULUS IV or MATH UN1208 HONORS MATHEMATICS B; and MATH UN3027 Ordinary Differential Equations or the equivalent.

Recommended cognate courses: MATH UN2010 LINEAR ALGEBRA, MATH UN3007 COMPLEX VARIABLES, and MATH UN3028 PARTIAL DIFFERENTIAL EQUATIONS.

Concentration in Physics

The concentration in physics requires a minimum of 24 points in physics, including one of the introductory sequences.

Interdisciplinary Major

It is also possible to major in astrophysics, biophysics, and chemical physics. Students interested in these areas should consult with the director of undergraduate studies and with cognate departments (astronomy, biological sciences, chemistry).

For astrophysics requirements please see:

http://bulletin.columbia.edu/columbia-college/departments-instruction/astronomy/#requirementstext

For biophysics requirements please see:

http://bulletin.columbia.edu/columbia-college/departments-instruction/biological-sciences/#requirementstext

For chemical physics requirements please see:

http://bulletin.columbia.edu/columbia-college/departments-instruction/chemistry/#requirementstext

PHYS UN1001 PHYSICS FOR POETS. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: high school algebra.
Prerequisites: high school algebra. This course does not fulfill the physics requirement for admission to medical school. No previous background in physics is expected. An introduction to physics taught through the exploration of the scientific method, and the application of physical principles to a wide range of topics from quantum mechanics to cosmology

Spring 2024: PHYS UN1001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1001	001/11289	M W 2:40pm - 3:55pm 301 Pupin Laboratories	Szabolcs Marka	3.00	126/150

PHYS UN1018 WEAPONS OF MASS DESTRUCTION. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: high school science and math.
Prerequisites: high school science and math. A review of the history and environmental consequences of nuclear, chemical, and biological weapons of mass destruction (WMD); of how these weapons work, what they cost, how they have spread, how they might be used, how they are currently controlled by international treaties and domestic legislation, and what issues of policy and technology arise in current debates on WMD. What aspects of the manufacture of WMD are easily addressed, and what aspects are technically challenging? It may be expected that current events/headlines will be discussed in class

Spring 2024: PHYS UN1018

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1018	001/11290	T Th 2:40pm - 3:55pm 428 Pupin Laboratories	Szabolcs Marka	3.00	74/130

PHYS UN1111 ORIGINS AND MEANING. *3.00 points*.
This course is a one-semester journey across cosmological history, from the beginning of time to something akin to its end. We will explore the origin of inanimate physical structures (the cosmos as a whole, as well as that of galaxies, stars, planets, particles, atoms and complex molecules), the origin of life (replicating molecules, the first cells, as well as more complex life forms), the origin of mind (self-reflective conscious awareness) and the origin of culture (language, myth, religion, art, and science). We will then consider what science in particular tells us about the very far future, where we will encounter the likely demise of all complex matter, all life and all consciousness. In the face of such disintegration we will examine the nature of value and purpose. We will recognize that the deepest understanding of reality emerges from blending all of the accounts we discuss—from the reductionist to the humanist to the cosmological—and only through such amalgamation can we fully grasp the long-standing human search for meaning

PHYS UN1201 GENERAL PHYSICS I. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: some basic background in calculus or be concurrently taking MATH UN1101 Calculus I.,The accompanying laboratory is PHYS UN1291-UN1292
Prerequisites: some basic background in calculus or be concurrently taking MATH UN1101 Calculus I. The accompanying laboratory is PHYS UN1291-UN1292 The course will use elementary concepts from calculus. The accompanying laboratory is PHYS UN1291 - UN1292. Basic introduction to the study of mechanics, fluids, thermodynamics, electricity, magnetism, optics, special relativity, quantum mechanics, atomic physics, and nuclear physics

Spring 2024: PHYS UN1201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1201	001/11291	M W 4:10pm - 5:25pm 428 Pupin Laboratories	Eric Raymer	3.00	129/145

PHYS UN1202 GENERAL PHYSICS II. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: This course will use elementary concepts from calculus. Students should therefore have had some high school calculus, or be concurrently enrolled in MATH UN1101. Taken with accompanying lab PHYS UN1291- PHYS UN1292, the sequence PHYS UN1201- PHYS UN1202 satisfies requirements for medical school.
Prerequisites: This course will use elementary concepts from calculus. Students should therefore have had some high school calculus, or be concurrently enrolled in MATH UN1101. Taken with accompanying lab PHYS UN1291- PHYS UN1292, the sequence PHYS UN1201- PHYS UN1202 satisfies requirements for medical school. Electricity, magnetism, optics, and modern physics

Spring 2024: PHYS UN1202

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1202	001/11292	M W 11:40am - 12:55pm 301 Pupin Laboratories	Michael Shaevitz	3.00	104/160
PHYS 1202	003/11293	M W 5:40pm - 6:55pm 301 Pupin Laboratories	P. Michael Tuts	3.00	175/160

PHYS UN1203 GENERAL PHYSICS I - REC. *0.00 points*.

Spring 2024: PHYS UN1203

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1203	001/12382	M 6:10pm - 7:00pm 325 Pupin Laboratories	Eric Raymer	0.00	23/24
PHYS 1203	002/12385	T 5:10pm - 6:00pm 424 Pupin Laboratories	Eric Raymer	0.00	23/24
PHYS 1203	003/12386	T 6:10pm - 7:00pm 224 Pupin Laboratories	Eric Raymer	0.00	22/24
PHYS 1203	004/12392	W 6:10pm - 7:00pm 313 Pupin Laboratories	Eric Raymer	0.00	25/24
PHYS 1203	005/12396	Th 5:10pm - 6:00pm 424 Pupin Laboratories	Eric Raymer	0.00	24/24
PHYS 1203	006/12397	Th 6:10pm - 7:00pm 424 Pupin Laboratories	Eric Raymer	0.00	12/24

PHYS UN1204 GENERAL PHYSICS II - REC. *0.00 points*.

Spring 2024: PHYS UN1204

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1204	001/12478	M 4:10pm - 5:00pm 425 Pupin Laboratories	Michael Shaevitz	0.00	20/22
PHYS 1204	002/12480	M 5:10pm - 6:00pm 425 Pupin Laboratories	Michael Shaevitz	0.00	22/22
PHYS 1204	003/12483	M 6:10pm - 7:00pm 425 Pupin Laboratories	Michael Shaevitz	0.00	11/22
PHYS 1204	004/12486	M 7:10pm - 8:00pm 425 Pupin Laboratories	Michael Shaevitz	0.00	8/22
PHYS 1204	005/12489	T 3:10pm - 4:00pm 414 Pupin Laboratories	Michael Shaevitz	0.00	16/22
PHYS 1204	006/12493	T 4:10pm - 5:00pm 325 Pupin Laboratories	Michael Shaevitz	0.00	18/22
PHYS 1204	007/12494	T 5:10pm - 6:00pm 325 Pupin Laboratories	Michael Shaevitz	0.00	6/22
PHYS 1204	011/12502	W 3:10pm - 4:00pm 224 Pupin Laboratories	P. Michael Tuts	0.00	23/25
PHYS 1204	012/12503	W 4:10pm - 5:00pm 224 Pupin Laboratories	P. Michael Tuts	0.00	22/25
PHYS 1204	013/12504	T 5:10pm - 6:00pm 328 Uris Hall	P. Michael Tuts	0.00	19/25
PHYS 1204	014/12508	T 6:10pm - 7:00pm 222 Pupin Laboratories	P. Michael Tuts	0.00	26/25
PHYS 1204	015/12511	W 7:10pm - 8:00pm 224 Pupin Laboratories	P. Michael Tuts	0.00	26/25
PHYS 1204	016/12515	M 3:10pm - 4:00pm 224 Pupin Laboratories	P. Michael Tuts	0.00	24/25
PHYS 1204	017/12518	M 4:10pm - 5:00pm 224 Pupin Laboratories	P. Michael Tuts	0.00	24/25
PHYS 1204	018/12522	Th 5:10pm - 6:00pm 253 Engineering Terrace	P. Michael Tuts	0.00	13/25

PHYS UN1291 GENERAL PHYSICS I LAB. *1.00 point*.
Same course as *PHYS W1291x*, but given off-sequence.

Corequisites: PHYS UN1201
Corequisites: PHYS UN1201 This course is the laboratory for the corequisite lecture course and can be taken only during the same term as the corresponding lecture

Spring 2024: PHYS UN1291

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1291	001/11317	M 1:00pm - 4:00pm Room TBA	Giuseppina Cambareri	1.00	13/15
PHYS 1291	002/11337	M 7:30pm - 10:30pm Room TBA	Giuseppina Cambareri	1.00	9/15
PHYS 1291	003/11359	T 1:00pm - 4:00pm Room TBA	Giuseppina Cambareri, Rebecca Grossman	1.00	13/15
PHYS 1291	004/11360	T 4:10pm - 7:10pm Room TBA	Giuseppina Cambareri	1.00	12/15
PHYS 1291	005/11361	W 1:00pm - 4:00pm Room TBA	Giuseppina Cambareri, Rebecca Grossman	1.00	15/15
PHYS 1291	006/11362	W 7:30pm - 10:30pm Room TBA	Giuseppina Cambareri	1.00	8/15
PHYS 1291	007/11363	Th 1:00pm - 4:00pm Room TBA	Giuseppina Cambareri	1.00	12/15
PHYS 1291	008/11364	Th 4:10pm - 7:10pm Room TBA	Giuseppina Cambareri	1.00	10/15

PHYS UN1292 GENERAL PHYSICS II LABORATORY. *1.00 point*.
Corequisites: PHYS UN1201,PHYS UN1202
Corequisites: PHYS UN1201,PHYS UN1202 This course is the laboratory for the corequisite lecture course (PHYS UN1201 - PHYS UN1202) and can be taken only during the same term as the corresponding lecture

Spring 2024: PHYS UN1292

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1292	001/11366	M 1:00pm - 4:00pm Room TBA	Giuseppina Cambareri, Rebecca Grossman	1.00	13/15
PHYS 1292	002/11367	M 1:00pm - 4:00pm Room TBA	Giuseppina Cambareri	1.00	14/15
PHYS 1292	003/11368	M 4:10pm - 7:10pm Room TBA	Giuseppina Cambareri	1.00	12/15
PHYS 1292	005/11370	M 7:30pm - 10:30pm Room TBA	Giuseppina Cambareri	1.00	13/15
PHYS 1292	007/11371	T 1:00pm - 4:00pm Room TBA	Giuseppina Cambareri	1.00	13/15
PHYS 1292	008/11372	T 1:00pm - 4:00pm Room TBA	Giuseppina Cambareri	1.00	14/15
PHYS 1292	009/11373	T 4:10pm - 7:10pm Room TBA	Giuseppina Cambareri, Rebecca Grossman	1.00	15/15
PHYS 1292	010/11374	T 4:10pm - 7:10pm Room TBA	Giuseppina Cambareri	1.00	11/15
PHYS 1292	011/11375	T 7:30pm - 10:30pm Room TBA	Giuseppina Cambareri	1.00	13/15
PHYS 1292	013/11376	W 1:00pm - 4:00pm Room TBA	Giuseppina Cambareri	1.00	15/15
PHYS 1292	014/11377	W 1:00pm - 4:00pm Room TBA	Giuseppina Cambareri	1.00	15/15
PHYS 1292	015/11378	W 4:10pm - 7:10pm Room TBA	Giuseppina Cambareri	1.00	13/15
PHYS 1292	017/11380	W 7:30pm - 10:30pm Room TBA	Giuseppina Cambareri	1.00	14/15
PHYS 1292	018/11381	Th 1:00pm - 4:00pm Room TBA	Giuseppina Cambareri	1.00	15/15
PHYS 1292	019/11382	Th 1:00pm - 4:00pm Room TBA	Giuseppina Cambareri	1.00	14/15
PHYS 1292	020/11383	Th 4:10pm - 7:10pm Room TBA	Giuseppina Cambareri	1.00	14/15
PHYS 1292	022/11385	Th 7:30pm - 10:30pm Room TBA	Giuseppina Cambareri	1.00	11/15
PHYS 1292	025/11386	F 1:00pm - 4:00pm Room TBA	Giuseppina Cambareri	1.00	10/15

PHYS UN1401 INTRO TO MECHANICS # THERMO. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Corequisites: MATH UN1101
Corequisites: MATH UN1101 Fundamental laws of mechanics, kinematics and dynamics, work and energy, rotational dynamics, oscillations, gravitation, fluids, temperature and heat, gas laws, the first and second laws of thermodynamics. Corequisite: MATH UN1101 or the equivalent

PHYS UN1402 INTRO ELEC/MAGNETSM # OPTCS. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: PHYS UN1401
Corequisites: MATH UN1102
Prerequisites: PHYS W1401. Corequisites: MATH V1102 or the equivalent. Electric fields, direct currents, magnetic fields, alternating currents, electromagnetic waves, polarization, geometrical optics, interference, and diffraction

Spring 2024: PHYS UN1402

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1402	001/11826	M W 10:10am - 11:25am 301 Pupin Laboratories	Eric Raymer	3.00	146/150
PHYS 1402	002/11294	M W 1:10pm - 2:25pm 301 Pupin Laboratories	Hector Ochoa	3.00	118/150
PHYS 1402	003/11295	T Th 10:10am - 11:25am 301 Pupin Laboratories	Lam Hui	3.00	142/150

PHYS UN1403 INTRO-CLASSCL # QUANTUM WAVES. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: PHYS UN1402 *PHYS W1402*.
Corequisites: *MATH V1201* or the equivalent.
Prerequisites: PHYS UN1402 PHYS W1402. Corequisites: MATH V1201 or the equivalent. Classical waves and the wave equation, Fourier series and integrals, normal modes, wave-particle duality, the uncertainty principle, basic principles of quantum mechanics, energy levels, reflection and transmission coefficients, applications to atomic physics

PHYS UN1404 INTRO TO MECH # THERMO - REC. ***0.00 points.***

PHYS UN1405 INTRO ELEC/MAGNETSM/OPT-REC. ***0.00 points.***

Spring 2024: PHYS UN1405

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1405	001/12530	M 5:10pm - 6:00pm 414 Pupin Laboratories	Eric Raymer	0.00	24/27
PHYS 1405	002/12545	M 6:10pm - 7:00pm 467 Ext Schermerhorn Hall	Eric Raymer	0.00	27/27
PHYS 1405	003/12546	T 5:10pm - 6:00pm 603 Hamilton Hall	Eric Raymer	0.00	27/27
PHYS 1405	004/12548	T 6:10pm - 7:00pm 603 Hamilton Hall	Eric Raymer	0.00	19/27
PHYS 1405	005/12549	T 7:10pm - 8:00pm 603 Hamilton Hall	Eric Raymer	0.00	14/27
PHYS 1405	006/12550	W 5:10pm - 6:00pm 420 Pupin Laboratories	Eric Raymer	0.00	24/27
PHYS 1405	007/12555	W 6:10pm - 7:00pm 467 Ext Schermerhorn Hall	Eric Raymer	0.00	13/27
PHYS 1405	011/12562	T 4:10pm - 5:00pm 307 Pupin Laboratories	Hector Ochoa	0.00	28/27
PHYS 1405	012/12563	T 5:10pm - 6:00pm 703 Hamilton Hall	Hector Ochoa	0.00	12/27
PHYS 1405	014/12567	W 3:10pm - 4:00pm 333 Uris Hall	Hector Ochoa	0.00	29/27
PHYS 1405	015/12568	W 4:10pm - 5:00pm 333 Uris Hall	Hector Ochoa	0.00	23/27
PHYS 1405	016/12574	W 5:10pm - 6:00pm 333 Uris Hall	Hector Ochoa	0.00	15/27
PHYS 1405	017/12577	W 6:10pm - 7:00pm 333 Uris Hall	Hector Ochoa	0.00	12/27
PHYS 1405	021/12580	M 4:10pm - 5:00pm 313 Pupin Laboratories	Lam Hui	0.00	28/28
PHYS 1405	022/12581	M 5:10pm - 6:00pm 313 Pupin Laboratories	Lam Hui	0.00	15/27
PHYS 1405	023/12582	T 4:10pm - 5:00pm 224 Pupin Laboratories	Lam Hui	0.00	29/27
PHYS 1405	024/12583	T 5:10pm - 6:00pm 224 Pupin Laboratories	Lam Hui	0.00	18/27
PHYS 1405	025/12584	W 4:10pm - 5:00pm 313 Pupin Laboratories	Lam Hui	0.00	26/27
PHYS 1405	027/15496	Th 4:10pm - 5:00pm 224 Pupin Laboratories	Lam Hui	0.00	24/25

PHYS UN1493 INTRO TO EXPERIMENTAL PHYS-LAB. ***3.00 points.***

PHYS UN1494 INTRO TO EXPERIMENTAL PHYS-LAB. ***3.00 points.***

Prerequisites: PHYS UN1401 and PHYS UN1402

Prerequisites: PHYS W1401 and W1402. Laboratory work associated with the two prerequisite lecture courses. Experiments in mechanics, thermodynamics, electricity, magnetism, optics, wave motion, atomic physics, and nuclear physics. Note: Students cannot receive credit for both PHYS W1493 and W1494

Spring 2024: PHYS UN1494

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1494	001/11387	M 2:40pm - 3:40pm 428 Pupin Laboratories	Giuseppina Cambareri, Valerie Hsieh	3.00	12/15
PHYS 1494	001/11387	M 4:10pm - 7:10pm 5th Flr Pupin Laboratories	Giuseppina Cambareri, Valerie Hsieh	3.00	12/15
PHYS 1494	002/11388	M 2:40pm - 3:40pm 428 Pupin Laboratories	Giuseppina Cambareri, Valerie Hsieh	3.00	11/15
PHYS 1494	002/11388	M 7:30pm - 10:30pm 5th Flr Pupin Laboratories	Giuseppina Cambareri, Valerie Hsieh	3.00	11/15
PHYS 1494	006/11392	W 1:00pm - 4:00pm 5th Flr Pupin Laboratories	Giuseppina Cambareri, Valerie Hsieh	3.00	12/15
PHYS 1494	006/11392	M 2:40pm - 3:40pm 428 Pupin Laboratories	Giuseppina Cambareri, Valerie Hsieh	3.00	12/15
PHYS 1494	007/11393	M 2:40pm - 3:40pm 428 Pupin Laboratories	Giuseppina Cambareri, Valerie Hsieh	3.00	11/15
PHYS 1494	007/11393	W 4:10pm - 7:10pm 5th Flr Pupin Laboratories	Giuseppina Cambareri, Valerie Hsieh	3.00	11/15

PHYS UN1601 PHYSICS I:MECHANICS/RELATIVITY. ***3.50 points.***

CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: Corequisite: MATH UN1102 Calculus II or equivalent.
Prerequisites: Corequisite: MATH UN1102 Calculus II or equivalent.
Fundamental laws of mechanics, kinematics and dynamics, work and energy, rotational dynamics, oscillations, gravitation, fluids, introduction to special relativity and relativistic kinematics. The course is preparatory for advanced work in physics and related fields

PHYS UN1602 PHYSICS II: THERMO, ELEC # MAG. ***3.50 points.***

CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: PHYS UN1601 Corequisite: MATH UN1201 or equivalent.
Prerequisites: PHYS UN1601 Corequisite: MATH UN1201 or equivalent.
Temperature and heat, gas laws, the first and second laws of thermodynamics, kinetic theory of gases, electric fields, direct currents, magnetic fields, alternating currents, electromagnetic waves. The course is preparatory for advanced work in physics and related fields

Spring 2024: PHYS UN1602

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1602	001/11301	T Th 10:10am - 11:25am 428 Pupin Laboratories	Kerstin Perez	3.50	76/140

PHYS UN1603 PHYSICS I:MECHANICS/RELATIVITY-REC. *0.00 points*.

PHYS UN1604 PHYSICS II:THERMO,ELEC/MAG-REC. *0.00 points*.

Spring 2024: PHYS UN1604

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 1604	001/12590	T 4:10pm - 5:25pm 825 Seeley W. Mudd Building	Kerstin Perez	0.00	24/25
PHYS 1604	002/12591	T 5:40pm - 6:55pm 825 Seeley W. Mudd Building	Kerstin Perez	0.00	10/25
PHYS 1604	003/12593	W 4:10pm - 5:25pm 414 Pupin Laboratories	Kerstin Perez	0.00	19/25
PHYS 1604	004/12594	W 5:40pm - 6:55pm 214 Pupin Laboratories	Kerstin Perez	0.00	11/25
PHYS 1604	005/12595	Th 4:10pm - 5:25pm 307 Pupin Laboratories	Kerstin Perez	0.00	12/25

PHYS UN2001 SPECIAL RELATIVITY. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: a working knowledge of high school algebra, trigonometry, and physics. Some familiarity with calculus is useful but not essential. This course is a comprehensive, one-semester introduction to the essential ideas and mathematical structures underlying Einstein's Special Theory of Relativity. Among the topics covered will be: the relativity of simultaneity, time dilation, Lorentz contraction, velocity combination laws, time dilation over large distances, the Lorentz transformation, spacetime diagrams, the basic (seeming) paradoxes of special relativity, relativistic equations of motion and E = mc2.

PHYS UN2601 PHYSICS III:CLASS/QUANTUM WAVE. *3.50 points*.
Prerequisites: PHYS UN1402 or PHYS UN1602 Corequisite: MATH UN1202 or equivalent.
Prerequisites: PHYS UN1402 or PHYS UN1602 Corequisite: MATH UN1202 or equivalent. Classical waves and the wave equation, geometrical optics, interference and diffraction, Fourier series and integrals, normal modes, wave-particle duality, the uncertainty principle, basic principles of quantum mechanics, energy levels, reflection and transmission coefficients, the harmonic oscillator. The course is preparatory for advanced work in physics and related fields

PHYS UN2603 Physics III: Class/Quantum Wave - Rec. *0.00 points*.

PHYS UN2699 Experiments in Classical and Modern Physics. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (PHYS UN1601 or PHYS UN1401) and (PHYS UN1602 or PHYS UN1402) and PHYS UN2601 *PHYS W1601* (or *W1401*), *W1602* (or *W1402*), and *W2601*.
Laboratory work associated with the three prerequisite lecture courses. Experiments in mechanics, thermodynamics, electricity, magnetism, optics, wave motion, atomic physics, and nuclear physics.

PHYS UN2801 ACCELERATED PHYSICS I. *4.50 points*.
Prerequisites: Advanced Placement in physics and mathematics, or the equivalent, and the instructor's permission. (A special placement meeting is held during Orientation.)
Prerequisites: Advanced Placement in physics and mathematics, or the equivalent, and the instructor's permission. (A special placement meeting is held during Orientation.) This accelerated two-semester sequence covers the subject matter of PHYS UN1601, PHYS UN1602 and PHYS UN2601, and is intended for those students who have an exceptionally strong background in both physics and mathematics. The course is preparatory for advanced work in physics and related fields. There is no accompanying laboratory; however, students are encouraged to take the intermediate laboratory, PHYS UN3081, in the following year

PHYS UN2802 ACCELERATED PHYSICS II. *4.50 points*.
Prerequisites: PHYS UN2801
Prerequisites: PHYS UN2801 This accelerated two-semester sequence covers the subject matter of PHYS UN1601, PHYS UN1602 and PHYS UN2601, and is intended for those students who have an exceptionally strong background in both physics and mathematics. The course is preparatory for advanced work in physics and related fields. There is no accompanying laboratory; however, students are encouraged to take the intermediate laboratory, PHYS UN3081, in the following year

Spring 2024: PHYS UN2802

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 2802	001/11296	T Th 10:10am - 12:00pm 329 Pupin Laboratories	Yury Levin	4.50	23/60

PHYS UN2803 ACCELERATED PHYSICS I-REC. *0.00 points*.

PHYS UN2804 ACCELERATED PHYSICS II-REC. *0.00 points*.
Required discussion section for PHYS UN2802 Accelerated Physics II

PHYS UN3002 From Quarks To the Cosmos: Applications of Modern Physics. *3.5 points*.
Prerequisites: PHYS UN2601 or PHYS UN2802
This course reinforces basic ideas of modern physics through applications to nuclear physics, high energy physics, astrophysics and cosmology. The ongoing Columbia research programs in these fields are used as practical examples. The course is preparatory for advanced work in physics and related fields.

PHYS UN3003 MECHANICS. *3.00 points*.
Prerequisites: general physics, and differential and integral calculus.
Prerequisites: general physics, and differential and integral calculus. Newtonian mechanics, oscillations and resonance, conservative forces and potential energy, central forces, non-inertial frames of reference, rigid body motion, an introduction to Lagranges formulation of mechanics, coupled oscillators, and normal modes

Spring 2024: PHYS UN3003

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3003	001/11297	T Th 1:10pm - 2:25pm 329 Pupin Laboratories	Cory Dean	3.00	64/75

PHYS UN3007 ELECTRICITY-MAGNETISM. *3.00 points*.
Prerequisites: general physics, and differential and integral calculus.
Prerequisites: general physics, and differential and integral calculus. Electrostatics and magnetostatics, Laplace's equation and boundary-value problems, multipole expansions, dielectric and magnetic materials, Faraday's law, AC circuits, Maxwell's equations, Lorentz covariance, and special relativity

PHYS UN3008 ELECTROMAGNETIC WAVES # OPTICS. *3.00 points*.
Prerequisites: PHYS UN3008
Prerequisites: PHYS UN3008 Maxwells equations and electromagnetic potentials, the wave equation, propagation of plane waves, reflection and refraction, geometrical optics, transmission lines, wave guides, resonant cavities, radiation, interference of waves, and diffraction

Spring 2024: PHYS UN3008

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3008	001/11298	M W 10:10am - 11:25am 329 Pupin Laboratories	William Zajc	3.00	58/75

PHYS UN3072 SEM IN CURRENT RES. PROBLEMS. *2.00 points*.
A detailed study of a selected field of active research in physics. The motivation, techniques, and results obtained to the present, as well as the difficulties and unsolved problems. For Physics majors only. Priority given to seniors; juniors by permission of the instructor

PHYS UN3081 INTERMEDIATE LABORATORY WORK. *2.00 points*.
May be repeated for credit by performing different experiments. The laboratory has available fifteen individual experiments, of which two are required per 2 points.

Prerequisites: phys UN2601 or phys un2802 Primarily for junior and senior physics majors; other majors must obtain the instructor's permission.
Prerequisites: phys UN2601 or phys un2802 Primarily for junior and senior physics majors; other majors must obtain the instructors permission. Each experiment is chosen by the student in consultation with the instructor. Each section meets one afternoon per week, with registration in each section limited by the laboratory capacity. Experiments (classical and modern) cover topics in electricity, magnetism, optics, atomic physics, and nuclear physics

Spring 2024: PHYS UN3081

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3081	002/14875	Th 1:10pm - 5:00pm 6th Flr Pupin Laboratories	Sebastian Will	2.00	12/16
PHYS 3081	003/11299	F 1:10pm - 5:00pm 6th Flr Pupin Laboratories	Morgan May	2.00	15/16

PHYS UN3083 ELECTRONICS LABORATORY. *3.00 points*.
Enrollment limited to the capacity of the laboratory.

Prerequisites: PHYS UN3003 or PHYS UN3007 May be taken before or concurrently with this course.
Prerequisites: PHYS UN3003 or PHYS UN3007 May be taken before or concurrently with this course. A sequence of experiments in solid-state electronics, with introductory lectures

Spring 2024: PHYS UN3083

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3083	001/11300	M W 1:10pm - 4:00pm 513 Pupin Laboratories	John Parsons	3.00	14/14

PHYS UN3084 Quantum Simulation and Computing Lab. *3.00 points*.
The "Quantum Simulation and Computing Lab" will give students hands-on experience in quantum optics, quantum simulation and quantum computing. The course combines lectures, tutorials, and two lab sections. In one lab section, students will do experiments with entangled photons. In the second lab section, students will program quantum computers and run algorithms on them using the IBM Qiskit platform. The course starts with a recap of linear algebra and quantum mechanics, followed by an introduction to quantum optics and quantum information. Two-level systems, Bloch sphere, quantum gates, and elementary quantum algorithms will be discussed. Quantum teleportation and quantum key distribution will be introduced as applications of entanglement. The lecture content will be directly applied in experiments with entangled photons. In the following, state-of-the-art quantum algorithms will be discussed, related to cutting-edge research results in quantum computing. This includes quantum Fourier transform, quantum simulation of the Schroedinger equation, and the variational quantum eigensolver (VQE) algorithm. During the course students will do one experimental project with entangled photons and one quantum programming project. Students will be guided to implement a quantum algorithm of their choice and run it on a quantum computer (IBM, IonQ, QuEra)

PHYS UN3500 SUPERVISED READINGS IN PHYSICS. *3.00 points*.
Prerequisites: the written permission of the faculty member who agrees to act as supervisor, and the director of undergraduate studies permission. Readings in a selected field of physics under the supervision of a faculty member. Written reports and periodic conferences with the instructor

Spring 2024: PHYS UN3500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3500	001/11302		Jeremy Dodd	3.00	1/10

PHYS UN3900 SUPERVISED INDIVIDUAL RESEARCH. *3.00-5.00 points*.
Prerequisites: Permission of the departmental representative required. For specially selected students, the opportunity to do a research problem in contemporary physics under the supervision of a faculty member. Each year several juniors are chosen in the spring to carry out such a project beginning in the autumn term. A detailed report on the research is presented by the student when the project is complete

Spring 2024: PHYS UN3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 3900	001/11303		Jeremy Dodd	3.00-5.00	17/20

PHYS GU4003 ADVANCED MECHANICS. *3.00 points*.
Prerequisites: differential and integral calculus, differential equations, and PHYS UN3003 or the equivalent.
Prerequisites: differential and integral calculus, differential equations, and PHYS UN3003 or the equivalent. Lagranges formulation of mechanics, calculus of variations and the Action Principle, Hamiltons formulation of mechanics, rigid body motion, Euler angles, continuum mechanics, introduction to chaotic dynamics

Spring 2024: PHYS GU4003

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 4003	001/11304	M W 4:10pm - 5:25pm 214 Pupin Laboratories	Frederik Denef	3.00	35/50

PHYS GU4011 PARTICLE ASTROPHYS # COSMOLOGY. *3.00 points*.
Prerequisites: (PHYS UN1403 or PHYS UN2601 or PHYS UN2802) and (MATH UN1202 or MATH UN1208) students are recommended but not required to have taken PHYS UN3003 and PHYS UN3007.
Prerequisites: (PHYS UN1403 or PHYS UN2601 or PHYS UN2802) and (MATH UN1202 or MATH UN1208) students are recommended but not required to have taken PHYS UN3003 and PHYS UN3007. An introduction to the basics of particle astrophysics and cosmology. Particle physics - introduction to the Standard Model and supersymmetry/higher dimension theories; Cosmology – Friedmann-Robertson-Walker line element and equation for expansion of universe; time evolution of energy/matter density from the Big Bang; inflationary cosmology; microwave background theory and observation; structure formation; dark energy; observational tests of geometry of universe and expansion; observational evidence for dark matter; motivation for existence of dark matter from particle physics; experimental searches of dark matter; evaporating and primordial black holes; ultra-high energy phenomena (gamma-rays and cosmic-rays)

PHYS GU4012 STRING THEORY. *3.00 points*.
Prerequisites: PHYS UN3003 and PHYS UN3008 and PHYS GU4021 . PHYS GU4023 would be helpful but is not required. Students should have some familiarity with tools for graphical presentation and numeric problem solving such as Mathematica and/or MatLab.
This course is intended as an introduction to string theory for undergraduates. No advanced graduate-level preparation is assumed, and the material will be covered at (no higher than) the advanced undergraduate level. Advanced topics such as supersymmetry, T-duality, and covariant quantization will not be covered. The focus will be on the dynamics of classical and quantum mechanical strings, with an emphasis on integrating undergraduate material in classical mechanics, relativity, electrodynamics and quantum mechanics.

PHYS GU4018 SOLID STATE PHYSICS. *3.00 points*.
Prerequisites: PHYS GU4021 and PHYS GU4023 or the equivalent.
Prerequisites: PHYS GU4021 and PHYS GU4023 or the equivalent. Introduction to solid-state physics: crystal structures, properties of periodic lattices, electrons in metals, band structure, transport properties, semiconductors, magnetism, and superconductivity

Spring 2024: PHYS GU4018

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 4018	001/11305	T Th 2:40pm - 3:55pm 307 Pupin Laboratories	James McIver	3.00	19/30

PHYS GU4019 MATHEMATICL METHODS OF PHYSICS. *3.00 points*.
Prerequisites: PHYS UN3003 and PHYS UN3007 and differential and integral calculus; linear algebra; or the instructor's permission.
Prerequisites: PHYS UN3003 and PHYS UN3007 and differential and integral calculus; linear algebra; or the instructor's permission. This course will present a wide variety of mathematical ideas and techniques used in the study of physical systems. Topics will include: ordinary and partial differential equations; generalized functions; integral transforms; Green's functions; nonlinear equations, chaos, and solitons; Hilbert space and linear operators; Feynman path integrals; Riemannian manifolds; tensor analysis; probability and statistics. There will also be a discussion of applications to classical mechanics, fluid dynamics, electromagnetism, plasma physics, quantum mechanics, and general relativity

PHYS GU4021 QUANTUM MECHANICS I. *3.00 points*.
Prerequisites: PHYS UN3003 and PHYS UN3007
Prerequisites: PHYS UN3003 and PHYS UN3007 Formulation of quantum mechanics in terms of state vectors and linear operators. Three dimensional spherically symmetric potentials. The theory of angular momentum and spin. Identical particles and the exclusion principle. Methods of approximation. Multi-electron atoms

PHYS GU4022 QUANTUM MECHANICS II. *3.00 points*.
Prerequisites: PHYS GU4021. Formulation of quantum mechanics in terms of state vectors and linear operators, three-dimensional spherically symmetric potentials, the theory of angular momentum and spin, time-independent and time-dependent perturbation theory, scattering theory, and identical particles. Selected phenomena from atomic physics, nuclear physics, and elementary particle physics are described and then interpreted using quantum mechanical models

Spring 2024: PHYS GU4022

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 4022	001/11306	M W 11:40am - 12:55pm 329 Pupin Laboratories	Alfred Mueller	3.00	56/70

PHYS GU4023 THERMAL # STATISTICAL PHYSICS. *3.00 points*.
Prerequisites: PHYS GU4021 or the equivalent.
Prerequisites: PHYS GU4021 or the equivalent. Thermodynamics, kinetic theory, and methods of statistical mechanics; energy and entropy; Boltzmann, Fermi, and Bose distributions; ideal and real gases; blackbody radiation; chemical equilibrium; phase transitions; ferromagnetism

PHYS GU4024 Applied Quantum Mechanics. *3 points*.
Prerequisites: (PHYS GU4021 and PHYS GU4022)
In this course, we will learn how the concepts of quantum mechanics are applied to real physical systems, and how they enable novel applications in quantum optics and quantum information. We will start with microscopic, elementary quantum systems – electrons, atoms, and ions - and understand how light interacts with atoms. Equipped with these foundations, we will discuss fundamental quantum applications, such as atomic clocks, laser cooling and ultracold quantum gases - a synthetic form of matter, cooled down to just a sliver above absolute zero temperature. This leads us to manybody quantum systems. We will introduce the quantum physics of insulating and metallic behavior, superfluidity and quantum magnetism – and demonstrate how the corresponding concepts apply both to real condensed matter systems and ultracold quantum gases. The course will conclude with a discussion of the basics of quantum information science - bringing us to the forefront of today's quantum applications.

PHYS GU4040 INTRO TO GENERAL RELATIVITY. *3.00 points*.
Prerequisites: PHYS UN3003 and PHYS UN3007 or the equivalent.
Prerequisites: PHYS UN3003 and PHYS UN3007 or the equivalent. Tensor algebra, tensor analysis, introduction to Riemann geometry. Motion of particles, fluid, and fields in curved spacetime. Einstein equation. Schwarzschild solution; test-particle orbits and light bending. Introduction to black holes, gravitational waves, and cosmological models

Spring 2024: PHYS GU4040

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PHYS 4040	001/11307	T Th 4:10pm - 5:25pm 214 Pupin Laboratories	James Hill	3.00	24/50

PHYS GU4050 Introduction to Particle Physics. ***3.00 points*****.**
Prerequisites: PHYS UN2601 or PHYS UN2802 or the equivalent.
Prerequisites: PHYS UN2601 or PHYS UN2802 or the equivalent. This course covers the Standard Model of Particle Physics, including it conception, successes, and limitations, with the goal of introducing upper-level physics majors to the foundations and current status of particle physics as a field of research. Specific topics to be covered include: historical introduction and review of the Standard Model; particle interactions and particle dynamics; relativistic kinematics; Feynman calculus, quantum electrodynamics, quantum chromodynamics, and weak interactions; electroweak unification and the Higgs mechanism; neutrino oscillations; and beyond-standard model physics and evidence. Along the way, students will research special topics and familiarize themselves with particle physics research

PHYS GU4051 ADVANCED LABORATORY WORK. ***2.00 points*****.**
Prerequisites: the instructors permission. The laboratory has 13 available individual experiments, of which two are required per 2 points. Each experiment requires two (four-hour) laboratory sessions. Registration is limited by the laboratory capacity. May be repeated for credit with different experiment selection. Experiments (classical and modern) cover topics in electricity, magnetism, optics, atomic physics, and nuclear physics

PHYS GU4998 SUPERVISED READINGS. ***3.00 points*****.**